

it in one of his memoirs, and his explanation seems to account for it in a most perfect and philosophical manner.

In the Daguerrotype process, it will be remembered, a silvered plate is subjected to the vapour of iodine (or of iodine and bromine), and thus receives a fine layer of a compound which is sensitive to light. When a plate so prepared is exposed to a lenticular image in the camera, the light causes the iodide (or bromoiodide) of silver to throw off iodine (or this together with bromine), which is immediately seized by the silver beneath, and thus forms a deeper layer of the sensitive salt. The depth, almost immeasurable though it be, depends on the intensity of, and length of exposure to, the light. (That this is the case has been proved by the fact that, if the sensitive layer be removed by a suitable solvent, the surface beneath is shown by reflected light to be etched to a greater or less degree.) The invisible image thus formed is exposed to mercury vapour, and the dew condenses on it proportionately to the depth of the layer. Quincké, in his memoir "On the Edge Angle and Spread of Liquids on Solid Bodies,"¹ shows that the edge angle of a drop of liquid on a solid body varies from zero to a constant quantity, according to the thickness of any fine layer of impurity which may be on the latter. When this layer attains a certain value then the edge angle of the drop will remain constant. The thickness, or rather the thinness, of the layer may be appreciated when it is stated that it bears a relation to what is called "the radius of the sphere of sensible action of molecular forces," and is usually greater than .00005 millimetre. In this case the sensitive plate is the solid body and the invisible image forms different thicknesses of impurity. By this difference in the edge angles of the mercury dew, condensed on different portions of the latent image, the light is reflected in different ways, which gives rise to the visible image.

This explanation entirely does away with the necessity, which previously seemed to exist, of the silver iodide (or bromo-iodide) being reduced to the metallic state, in order to cause condensation, or—perhaps it might be said—to cause the formation of an amalgam of mercury and silver.

The next method of development speaks for itself; the metallic silver is deposited in fine granules and is attracted by the salt which has been altered by the influence of light. Perhaps further investigation will show that development is dependent on what is known as the Brownian movement, or the rapid movement of small suspended particles in a liquid. If this movement be dependent on the electrical condition of the neighbouring body, as has lately been supposed; and if, as Dewar has shown, the condition of an exposed sensitive salt is electrical, then the deposition of the metallic particles of silver on the image is accounted for in a satisfactory manner.

The last mode of development is principally employed with silver bromide, and is known as the alkaline method. When a film of collodion or gelatine holds a sensitive salt on a plate, the portions exposed to light are reduced to the metallic state by the application of an oxygen absorbent such as alkaline pyrogallol acid. Since the image is invisible, it must be remembered that but a few molecules of the sensitive salt are reduced by the action of light to the less complex and developable form, we therefore must look for some further action between the developer and the rest of the unaltered compound. It has lately been proved that silver bromide or silver chloride cannot exist in *close* contact with metallic silver. It invariably forms the developable salt. Thus if we take a glass plate, silvered by any of the well-known processes, and expose it to the fumes of bromine or to hypobromous anhydride, it will be found that it is impossible to secure a film of argentic bromide until the last trace of silver has been attacked, after which the true colour of argentic bromide gradually

gives way to the well-known colour of argentic bromide. We may try the experiment with bromine water and the same holds good. The action of chlorine on silver is the same as of bromine, but the action of iodine seems to be different, the fully saturated compound, argentic iodide, being formed at first. In other words, this compound is the more stable than argentic iodide.

Now the alkaline developer, when mixed with a soluble bromide of an alkali, has the property of much more readily attacking the argentic than the argentic bromide, presumably because the soluble bromide used in development combines with the former, giving rise to an apparently difficultly reducible compound, whilst it refuses to combine with the argentic salt. It is thus easy to see, if this property of the developing solution be connected with what was stated in the preceding paragraphs, how development takes place. The developer is applied to the exposed film, and the minute quantity of argentic compound is reduced to the metallic state, and at once this particle of silver which is in close contact with the unaltered compound combines with it and forms new argentic bromide. This is ready for attack by the developer, and thus the action spreads till the whole thickness of the sensitive salt is reduced to the metallic state where the greatest exposure has taken place. An interesting result¹ of this action is afforded by the fact that, if a film of unexposed argentic bromide be superposed over one that has been exposed, the image impressed on the latter can be developed in the former so long as close contact is secured. It has been said that this action is due to the solubility of the silver-bromide used in the alkaline development; and, to some extent, this is true; but it is evident that this cannot be explanatory of the whole phenomenon, since the same effect is produced by using, with the pyrogallol acid, potash as the alkali in which the silver-bromide is absolutely insoluble. We have been thus particular in showing the cause of this alkaline development, as it explains some phenomena to which attention will subsequently be called, and which otherwise would be inexplicable, except by reversing usually-accepted physical laws.

W. DE WIVELESIE ABNEY

(To be continued.)

MILITARY BALLOONING

THE matter of ballooning for military purposes appears to be once more attracting attention in this country. In France they have now a properly organised service under the command of a colonel of the National Engineers, who considers all novelties and proposals as they arise, and who sees, moreover, that the State has always a body of skilled aeronauts at its disposal. At the end of the Paris siege the Postal department, it may be remembered, possessed a large number of balloons, and these being handed over to the French war minister, constituted the *matériel* necessary in the formation of a military balloon service. Col. Laussedat, whose name as an energetic officer of the French Topographical Department, is well known, was placed in command, and he at once secured the services of one of the Messrs. Goddard to put the whole of the apparatus in a fit condition for service. Since that day ballooning in France has been considered as much a duty of the Engineers of the army as telegraphing and surveying, and classes both for officers and men are held for instruction. Lately, by the resignation of Col. Laussedat, the French balloon service has lost its chief support; but his place has just been supplied by Gen. Farr, who will, no doubt, take measures to maintain the high efficiency which has been attained by his predecessor.

In France, as in this country, the balloon is chiefly

¹ *Phil. Mag.*, May and June, 1878.

Phil. Mag., January, 1877.

regarded by military men as an important means of reconnoitring. The Paris photographer and aéronaut, Nadar, was successful on several occasions in securing photographic records from balloons, but he never published his *modus operandi*; and the problem of balloon photography is one which still excites a good deal of attention. Mr. Walter Woodbury, the well-known inventor of Woodburytype—the only practical photo-engraving process we know—submitted, during the last war, to the Russian government, a very ingenious method of securing pictures at an altitude. By his plan no one ascends with the balloon at all, and therefore the latter may be of very limited dimensions. It is captive, and twisted into the tethering rope are insulated wires in connection with a camera. The camera is weighted and hung upon a pivot so as to be always horizontal, and a fan attached to the balloon prevents the same from gyrating. It is easy to understand how a lens may be capped and uncapped from below with the aid of an electric current, and the photographs are secured—for a series may be taken at one ascent—upon a length of sensitive tissue which is unrolled for use through the medium of clockwork. The sensitive tissue and roller arrangement is that of M. Warnerke, which is known to all dry plate workers, and which permits of securing pictures without glass. Mr. Woodbury's invention has, so far, been tested only in respect to its photographic properties, but in cases where an aéronaut would run too much risk, or where a large supply of gas is not available, the apparatus would be well worthy of trial.

It is the difficulty of securing a sufficiency of gas for inflation that at present stands in the way of employing balloons in the field. The French balloons are all large ones, for they were constructed most of them for postal service during the siege, and, besides the mails and aéronaut, sometimes carried three passengers. With the exception of half-a-dozen, all the balloons which left Paris had a uniform capacity of 2,000 cubic metres, while one, in which M. de Fonvielle and three other persons travelled from Paris to Louvain, measured 3,000 metres. Such bulky balloons as these are unsuited for the field, where the problem is to send a single observer aloft with the minimum amount of time and trouble. The smallest balloon and the lightest gas for the purpose are what the soldier seems to require, and it is towards these two points that attention has lately been directed by Capt. Templar and the other officers who are just now occupied in the study of aerial navigation in this country. Naturally enough, hydrogen holds out the most promising features as a lifting medium, and it is with this gas that experiments are once more to be made. As our readers remember, the weight of hydrogen is calculated to be 2.14 grains per 100 cubic inches, while air on the other hand weighs 31 grains; and, as the lifting power is represented by the difference between these numbers, it stands to reason that theoretically, a balloon, if filled with hydrogen, need be of but comparatively very small dimensions. Unfortunately, in a practical affair like ballooning, a lot of accidental matters require to be taken into consideration, and two of these are the facts that it is difficult to secure pure hydrogen, and more difficult still to keep it in the balloon envelope when secured. Capt. Templar is sanguine that a 10,000 cubic feet balloon is quite capable of lifting an observer high enough for reconnoitring purposes, if filled with hydrogen, and well-nigh proved his case the other day when he overcame gravity, if he did not rise, with the aid of a light coal-gas with which this small balloon was filled. The coal-gas, specially manufactured for his balloon, had a lifting-power of 50 lb. per 1,000 feet, so that a total of 500 lb. was here at his disposal. As we have said, this was insufficient for an ascent, for, besides the weight of the aéronaut, there are, it must be remembered, envelope, car, tackle, cable, and ballast to be taken into considera-

tion. Instead of 500 lb., hydrogen of the same volume would have supplied a lifting-power of 700 lb., and this of course would have been ample, and to spare, for an ascent.

To make this hydrogen recourse will be had, as in previous experiments undertaken by our military authorities, to the decomposition of water in the form of steam. The latter is to be passed through tubes filled with iron filings or turnings, and these, in becoming oxidised, set free the hydrogen. Unfortunately the hydrogen obtained in this way is impregnated with moisture, and unless submitted to the action of some desiccating agent like quicklime, for instance, is of little good for ballooning. The hydrogen it is proposed to obtain in the field, at any rate, in this fashion, and it remains to be proved whether Capt. Templar and his colleagues can secure it sufficiently pure and in proper quantity under these practical conditions. Although hydrogen is given off fast enough at the outset, previous experimenters have found the supply to fall off rapidly, for as soon as the surface of the particles becomes oxidised the decomposition of the steam ceases.

But perhaps the most interesting feature of the present ballooning experiment will be the trial of compressed gas. As our readers know very well, compressed gases are now a commercial article in this country, and you may purchase cylinders of oxygen or hydrogen at twenty atmospheres pressure. As our Royal Engineers carry about with them in the field such unwieldy things as pontoons, they can hardly grumble at a waggon load of hydrogen tubes, and with these it is suggested to fill a balloon just wherever a reconnaissance is to be made. On nearing the enemy the first convenient spot will be chosen for the manufacture of the hydrogen, and this will then be compressed, with the assistance of suitable apparatus, into the tubes, to be drawn off again when the ascent is to be made. In this way there is always to be gas at hand not only to fill the balloon but to keep up a constant supply for a limited period, since hydrogen, under the most favourable circumstances, rapidly exudes from a balloon envelope.

A military balloon, it appears to be decided, must be a captive one, and opportunity would of course be taken to place the observer in electrical communication with the earth through the medium of insulated wires twisted round the rope in the same way as in Mr. Woodbury's photo-aerial apparatus above described.

H. BADEN PRITCHARD

HYPNOTISM

THE phenomena of "hypnotism," "mesmerism," or "electro-biology," have of late years excited so much popular interest—not to say popular superstition—that their investigation by a competent man of science will appeal to the sympathies of a wider public than the purely scientific. My object, therefore, in writing the present article is to give a brief review of a monograph on this subject, which has just been published by the well-known physiologist, W. Preyer of Jena.¹

In order to eliminate all possible effects of the imagination, Preyer performed his experiments only upon animals, and he begins his paper with an historical sketch of previous investigations of a similarly restricted nature. First we have the "*Experimentum mirabile*" of the Jesuit Athanasius Kircher, published by him in the year 1646.² This consists in taking a common fowl, binding its feet together, and placing it on a floor. As soon as it has ceased to struggle a straight line of chalk is drawn from the point of its bill along the floor. If the legs are now

¹ Die Kataplexie und der thierische Hypnotismus. (Gustave Fischer, Jena, 1878.)

² In a postscript Preyer states that he has found this experiment to have been published ten years earlier, by Daniel Schwenter, and the quotation which he makes from Schwenter's book goes to prove that Kircher probably derived his knowledge of the experiment from that source.